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The Pennsylvania State University
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Final Report for NASA Grant NSG 5205

Utilization of Satellite Data in Mesoscale
Modeling of Severe Weather

Submitted by

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1. Introduction

The main area of research supported by this grant involved VAS-data impact studies using three meteorological cases. Two were modeling studies and one was an objective-analysis study -- all involved the use of VAS satellite data to augment radiosonde data for the production of meso/synoptic-scale analyses.

One modeling study used VAS data that were available over the Pacific Ocean at one time near the beginning of a particularly interesting cyclogenesis period. Model simulations of the 36-h cyclogenesis period illustrated the impact of VAS data on the accuracy of polar low intensification. Various procedures were evaluated for the utilization of the VAS temperature and moisture data. In addition to the straightforward use of these data in a conventional static initialization, a dynamic initialization procedure based on the Newtonian nudging technique was tested, as was a geostrophic-correction procedure for modifying the wind field based on the VAS temperature data. An abstract summarizing the results of this research is found in Appendix A, as is an associated manuscript that has been accepted for publication in Monthly Weather Review.

In a second study, various combinations of VAS data, conventional radiosonde data and gridded data from the National Weather Service's global analysis are used in successive-correction and variational objective-analysis procedures. The accuracy of these analysis techniques for combining the data are evaluated using special radiosonde data from the 1982 AVE/VAS Ground Truth Field Experiment. The results of this research are described in Appendix B in an abstract as well as a manuscript that has been submitted to Monthly Weather Review.

The third case study involves use of the Penn State/NCAR mesoscale model to test the impact of VAS data on a 12-h forecast of convective precipitation in the midwestern U.S.. The results are being summarized for submission as a note in Monthly Weather Review, and are described in Appendix C.

2. Publications

The following publications describe research that has been wholly or partially supported by this Grant. NASA support has been formally acknowledged in each.

a) Peer reviewed journal articles - accepted or submitted.

Salmon, E.M. and T.T. Warner, 1986: Short-term numerical precipitation forecasts initialized using a diagnosed divergent wind component. Mon. Wea. Rev., 114, 2122-2132.

Modica, G.M. and T.T. Warner, 1987: The error associated with use of various forms of the divergence equation to diagnose geopotential and temperature. Mon. Wea. Rev., to be published in January 1987.

Stauffer, D.R. and T.T. Warner, 1987: A numerical study of Appalachian cold-air damming and coastal frontogenesis. Mon. Wea. Rev., to be published in March 1987.

Douglas, S.G. and T.T. Warner, 1987: Incorporation of VAS satellite data in the initialization of a mesoscale model: An oceanic-cyclogenesis simulation. Mon. Wea. Rev., accepted.

Doyle, J.D. and T.T. Warner, 1987: Variational objective analysis of VAS satellite data: A case study of the 7 March 1982 AVE/VAS special network data. Mon. Wea. Rev., submitted.

b) Papers presented at meetings

Salmon, E.M. and T.T. Warner, 1983: The impact of the diagnostic initialization of divergence on short-term precipitation forecasts produced by a mesoscale model. Proceedings of the Sixth Conference on Numerical Weather Prediction, Omaha, NE, June 6-9, 1983

Stauffer, D.R. and T.T. Warner, 1983: A real-data numerical study of the boundary-layer structure associated with cold-air damming and coastal frontogenesis. Paper presented at the First Conference on Mesoscale Meteorology, Norman, OK, May 31-June 3, 1983.

Stauffer, D.R. and T.T. Warner, 1983: A real-data numerical study of the boundary-layer structure associated with coastal frontogenesis and cold-air damming. Proceedings of the Sixth Conference on Numerical Weather Prediction, Omaha, NE, June 6-9, 1983.

Nappi, A.J. and T.T. Warner, 1984: Operational modeling requirements for accurate short-range prediction of meso- and synoptic-scale precipitation associated with an Atlantic coastal storm - A case study. Proceedings of the Tenth Conference on Weather Forecasting and Analysis, Clearwater Beach, FL, June 25-29, 1984.

Stauffer, D.R. and T.T. Warner, 1984: A real-data numerical study of the boundary-layer structure associated with coastal frontogenesis and cold-air damming. Paper presented at the International Conference on Mesoscale Meteorology, Melbourne, Australia, February, 6-10, 1984.

Warner, T.T., 1984: The initialization of mesoscale models. Proceedings of the Nowcasting II Symposium, Norrkoping, Sweden, September 3-7 1984.

Warner, T.T. and E.M. Salmon, 1984: The impact of the diagnostic initialization of divergence on short-term precipitation forecasts provided by a mesoscale model. Paper presented at the International Conference on Mesoscale Meteorology, Melbourne, Australia, February 6-10, 1984.

Beauchamp, J.G. and T.T. Warner, 1985: Dynamic and static initialization of a mesoscale model using VAS satellite data. Proceedings of the Seventh Conference on Numerical Weather Prediction, Montreal, Canada, June 17-20, 1985.

Douglas, S.G. and T.T. Warner, 1985: Effect of VAS data on oceanic cyclogenesis modeling skill. Paper presented at the Fifth Extratropical Cyclone Project Workshop, Port Deposit, MD, April 22-25, 1985.

Modica, G.M. and T.T. Warner, 1985: The error associated with the use of various forms of the divergence equation to diagnose geopotential and temperature. Proceedings of the Seventh Conference on Numerical Weather Prediction, Montreal, Canada, June 17-20, 1985.

Warner, T.T., 1985: Effect of horizontal and vertical data resolution on quantitative precipitation forecasting skill. Paper presented at the Fifth Extratropical Cyclone Project Workshop, Port Deposit, MD, April 22-25, 1985.

Warner, T.T. and L.E. Key, 1985: The impact of data density and data error on the evolution of mesoscale forecast error. Proceedings of the Seventh Conference on Numerical Weather Prediction, Montreal, Canada, June 17-20, 1985.

c) Books or parts of books

Warner, T.T., D.. Keyser and L.W. Uccellini, 1983: Some practical insights into the relationship between initial state uncertainty and mesoscale predictability. Predictability of Fluid Motions, American Insititute of Physics.

d) Papers to be submitted

Beauchamp, J.G. and T.T. Warner, 1987: Dynamic and static initialization of a mesoscale model using VAS satellite data. Mon. Wea. Rev., (to be submitted as a note).

Key, L.E. and T.T. Warner, 1987: The impact of data density and data error on the evolution of mesoscale forecast error. Mon. Wea. Rev., (to be submitted).

Lario, A. and T.T. Warner, 1987: A spectral analysis of model forecast error: an observing system simulation approach. Mon. Wea. Rev. (to be submitted).